

ELECTROMAGNETIC RADIATION: A CAUSE OF SICK BUILDING SYNDROME

Sick Building Syndrome or SBS is slowly but surely intruding into our living spaces. Factors such as chemical and biological contaminants, inadequate lighting and ventilation have always been linked to Sick Building Syndrome, but there is a more potent threat enveloping the places we live and work

This paper is concerned with building occupants' complains of feeling of minor or acute discomfort or sick building syndrome (SBS). The reason of SBS may be manmade or natural. As long as the causes are limited to air pollution, biological contamination, and light & air ventilation, the results appear in a short duration & after diagnosis the treatment is also possible & within reach; but once the causes of SBS are noxious energies, then diagnosis & treatment, both get associated with long time span and unfortunately, many a times the results are irreversible, such as in cases of cancerous cells growth in occupant's body. An electromagnetic radiation is one of such noxious energies by which we are all surrounded (consciously or unconsciously) and there is a severe need of awareness of this fact & its remedies.

SICK BUILDING SYNDROME (SBS) is a situation in which occupants of a building experience acute health effects and the extent of these effects or sicknesses depend on the time duration which occupants spend at that location. Unfortunately, even after being an acute sufferer, it is difficult to identify any specific disease and its causes. The occupant just feels UNCOMFORTABLE. Such problem may be associated with a particular room or zone, or may be wide-spread throughout the building. Such conditions may be found at any residence as well at a place of work. A 1984 World Health Organization report suggested that up to 30% of new and remodelled buildings, worldwide, may be linked to symptoms of SBS.

COMMON SYMPTOMS OF SBS (Short term effects & deceases)

Building occupants complain of symptoms associated with acute discomfort. These symptoms include headaches; eye, nose, and throat irritation; a dry cough; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odours; and again the cause is always a mystery for common people.

SBS reduces workers' productivity and may also result in increased absenteeism.

CAUSES OF SBS

While specific causes of SBS remain unknown, the following have been cited as contributing factors to sick building syndrome. These elements may act in combination or may supplement other complaints such as inadequate temperature, humidity, or lighting.

- **Chemical contaminants from outdoor sources:** Outdoor air, that enters a building, can also be a source of indoor pollution. Pollutants from motor vehicle exhausts, plumbing vents, and building exhausts (bathrooms and kitchens) can enter the building through poorly located air intake vents, windows, and other openings. Combustion by-products can also enter a building from a nearby garage.
- **Chemical contaminants from indoor sources:** Most indoor air pollution comes from sources inside the building. e.g., adhesives, upholstery, carpeting, copy machines, manufactured wood products, cleaning agents and pesticides which may emit volatile organic compounds (VOCs),

including formaldehyde. Research shows that some VOCs can cause chronic and acute health effects at high concentrations, and some are known carcinogens. Low to moderate levels of multiple VOCs may also produce acute reactions in some individuals.

Environmental tobacco smoke and combustion products from stoves, fireplaces, and unvented space heaters, all can put chemical contaminants into air.

- **Biological contaminants:** Biological contaminants include pollen, bacteria, viruses, and moulds. These contaminants can breed in stagnant water that has accumulated in humidifiers, drain pans, and ducts, ceiling tiles, insulation, or carpet or where water or dampness has collected. Biological contaminants can cause fever, chills, cough, chest tightness, muscle aches, and allergic reactions. One indoor air bacterium, Legionella, has caused, both Pontiac Fever and Legionnaire's Disease.
- **Poor & inappropriate lighting and Inadequate ventilation, bad acoustics, poor ergonomics and humidity may also contribute to SBS:** Reduced ventilation rates have been found to be, in many cases, inadequate to maintain the health and comfort of building occupants. Malfunctioning heating, ventilation and air-conditioning systems (HVAC systems) also increase the indoor air pollution. In order to have an acceptable indoor air quality (IAQ) with minimum energy consumption, The American Society of Heating, Refrigeration and Air-Conditioning Engineers

(ASHRAE) has given ventilation standards to a minimum outdoor air flow rate of 15 cfm/person (cfm=cubic feet per minute) to avoid the problems related to inadequate ventilation. The standard air flow rate for offices is 20 cfm/person & for smoking lounge is 60 cfm/person.

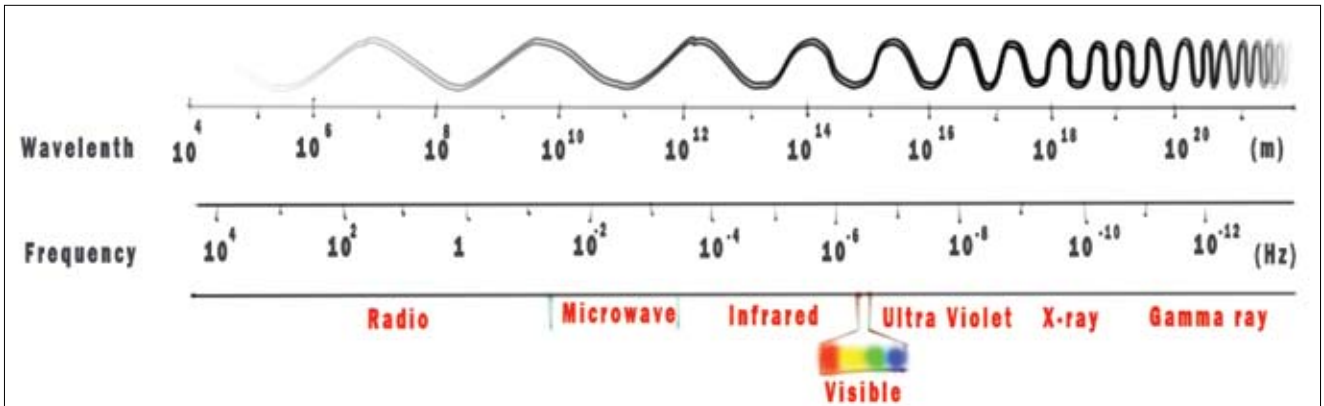
The symptoms of SBS because of poor lighting & inadequate ventilation are more common in air-conditioned buildings than in naturally ventilated buildings.

In view of the above discussed causes, most of the time, the results are associated with short duration & comparatively more easily discernible.

But in a few circumstances (**Long duration effects & deceases**), the habitants do not get any idea about the sickness of their living place (house/office), because the effects & causes, both are associated with **long duration** processes. The cause of this phenomenon is the impact of noxious energies (Electromagnetic radiations, Radio frequencies, Geopathic stress) on the human beings. The emission of these noxious energies may be natural as well as manmade.

Sources & effects of these is as follows:

- **Electromagnetic fields:** Sources include :
 - Clock, radios, Electric blankets
 - TV's, home entertainment systems and other electrical appliances
 - Charging units for mobile phones and other cordless electronic devices
 - Security systems control panels
 - Fuse boxes and house wiring
 - Power lines



Electromagnetic spectrum

The associated adverse health effects may include difficulty in concentration, dizziness, loss of memory, headaches, ringing in the ears, sleep disturbances, depression, fatigue, weakness, Immune suppression, cancer, miscarriage.

• Radio frequencies:

Sources include:

- Mobile phones and mobile phone towers
- Cordless phones
- Wireless electronic equipment

The associated adverse health effects may include sleep disturbances, tiredness, headaches, irritability, forgetfulness, learning difficulties, tinnitus etc.

• Geopathic stress: Sources include:

- Negative earth energies from geological faults, underground water sources
- Negative energies left behind by the previous inhabitants of a space

The associated adverse health effects may include cancer, multiple sclerosis, disturbed sleep, strange dreams or nightmares, tiredness, depression, headaches, repeated miscarriages, failure to thrive, learning difficulty.

It is important for researchers, technologists, physicians and public

health officials to be aware of the environmental health, fundamental science and clinical implications of Electromagnetic field (EMF) exposure & their solutions.

Electromagnetic Radiation

Electromagnetic waves are produced by the motion of electrically charged particles. These waves are also called electromagnetic radiation because they radiate from the electrically charged particles. They travel through empty space as well as through air and other substances. Electromagnetic waves, at low frequencies, are referred to as electromagnetic fields and those, at very high frequencies are called electromagnetic radiations.

Classification of Electromagnetic Waves

The electromagnetic spectrum includes several different classes of radiation: low frequency, radio waves, microwaves, infrared waves, visible light, ultraviolet light, x-rays and gamma rays. Wave frequencies differentiate one class of radiation from another. Electromagnetic radiations can be classified into two types: Ionizing radiation & Non-ionizing radiation. These are called so based

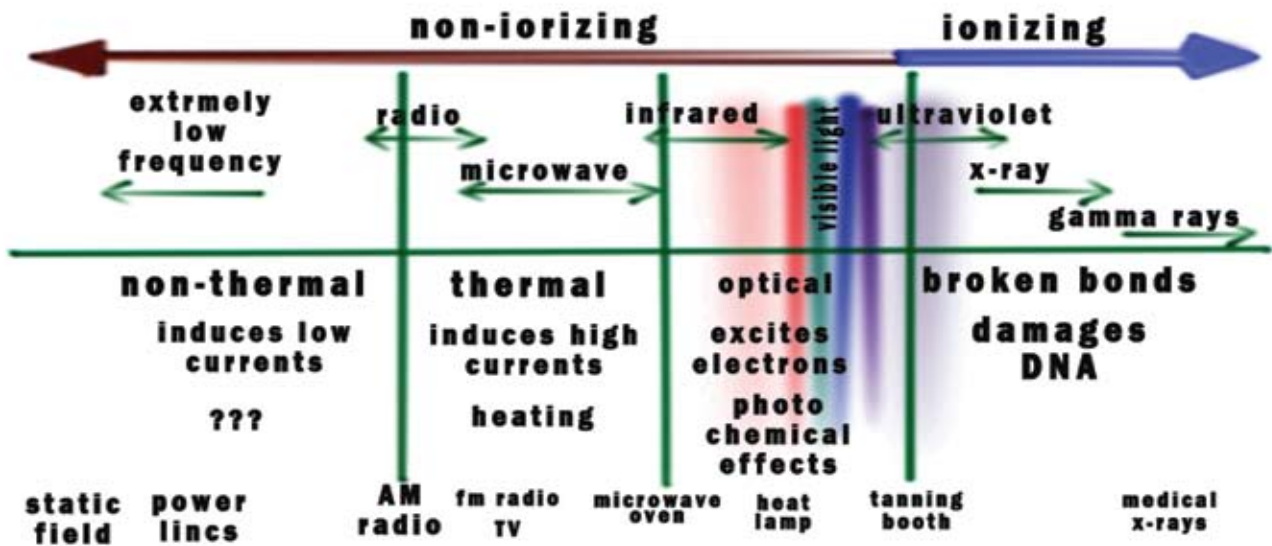
on whether they are capable of ionizing atoms and breaking covalent bonds or not.

Ultra violet and higher frequency radiations, such as X-rays or gamma rays are ionizing. Although these are highly dangerous & pose their own special effects on the life of human beings, these are rarely present at our dwelling places and workspaces. Electromagnetic pollution is due to Non-ionizing radiation (frequencies which are oscillating slower than visible light waves). Non-ionizing radiation is associated with two major potential hazards that are electrical and biological. Moreover, induced electric current, caused by radiation, can generate sparks and create a fire or explosive hazard.

The various devices which are responsible for electromagnetic pollution are as follows:

- Computers and related equipment
- Cellular (mobile) phones
- Information networks
- Electrical appliances
- Electronic equipments
- Cell phone masts
- Microwave ovens
- House-wiring
- High and low voltage power lines and many others

TYPES OF RADIATION



In reality, every new invention leads to electromagnetic pollution. The rate of increase is rising exponentially.

Electromagnetic Radiations (EMRs)

A) LOW FREQUENCY EMRS

Strong electromagnetic fields (EMFs) of low frequency, around 50 to 60 cycles per second (hertz, or Hz), are very harmful. It is possible to shield a house from electric field generated by nearby power lines but is difficult to provide shielding from magnetic field generated by them. The magnetic field can be shielded by using the underground transmission system but the cost is much higher than the overhead transmission line system. The long-term exposure of low frequency EMFs may give rise to various health problems especially lack of fatigue, irritability, aggression, hyperactivity, sleep disorders and emotional instability. As our day to day life is

surrounded with EMR generating equipments such as power lines, power tools, boilers, electric stoves, heaters, freezers and television sets, electric iron or an electric keyboard etc., large numbers of individuals are becoming hypersensitive to EMRs. Working with handheld power tools can quickly drain our energies. Stray currents and radiating fields can be present around us even if appliances are switched off. AC electric fields do not disappear when an appliance is switched off, only AC magnetic fields disappears.

When human body is exposed to electric field or magnetic field (any of these), no significant effect is observed on human body but adverse effect is observed on the human body when it is exposed to both electric and magnetic fields, i.e. electromagnetic radiations.

B) HIGH FREQUENCY EMRS

High frequency electromagnetic

field is mainly generated by the cellular phones, microwaves and antennas. High frequency EMFs are due to radio frequency energy in the frequency range of low, medium, high, very high, ultrahigh frequencies or microwaves and are often referred to as radio energies. The term radio frequency energy is used for all the frequencies between 30 kHz and 300GHz.

Biological effects of radio frequency (RF) energy are:

- The RF energy heats up the tissues in a similar manner as a microwave oven and it can be dangerous in case of prolonged exposure.
- Tissues can get damaged if exposed to RF energy because they are not capable of dissipating large amounts of generated heat. This can lead to skin burns, deep burns and heat strokes.
- Eyes are most affected by the RF energy because lack of blood flows to cornea which may lead to cataract.

Crux of report of the bioinitiative working group on the effects of EMFs:

(Bio Initiative Report: "A Rationale for Biologically-based Public Exposure Standards for Electromagnetic Radiation" at www.bioinitiative.org)

An International working group of leading scientists, researchers and public health policy professionals is bringing scientific concerns about the radiation to light.

Their 2007 report, the BioInitiative Report, concludes that the existing standards for public safety are completely inadequate to protect health. The report includes studies showing evidence of electromagnetic fields as under:

- Affects gene and protein expression (Transcriptomic and Proteomic Research)
- Have genotoxic effects – RFR and ELF DNA damage
- Induces stress response (Stress Proteins)
- Affects immune function
- Affects Neurology and behaviour
- Causes childhood cancers (Leukaemia)
- Impacts melatonin production; Alzheimer's Disease; Breast Cancer
- Promotes breast cancer (Melatonin links in laboratory and cell studies)

Other well-known studies link EMFs to:

- Enzyme changes that affect DNA and cell growth; possible result is cancer and birth defects
- Changed metabolism and increased cell growth
- Fatal abnormalities, probably caused by enzyme changes
- Gene expression changes, which

creates stress on your body and even result in cancer

- Increased production of stress proteins within cells, linked to Alzheimer's disease
- Chronic stress, which can lead to heart conditions
- Neuro-hormone changes, which can result in memory loss and impaired brain function
- Electro-smog disturbs the growth of cells and the information flow between cells

The Notable Dangers of Cell Phone Electromagnetic Radiation

Because cell phones have such powerful EMFs (usually in the microwave range!) and are held to the head or kept close to the body, they are especially dangerous. (See *cell phone studies for links to specific research.*)

- Cell phones emit two kinds of EMFs - microwave electromagnetic radiation from the antenna, and more EMFs from the phone body – both are harmful
- 20-80% of the radiation from a phone's antenna penetrates up to 2 inches into the adult brain
- Cell phones have thermal effects (they heat biological tissue) as well as non-thermal effects (affecting natural EMF frequencies)
- Studies have shown that people who sleep with a cell phone by the bed have poor REM sleep, leading to impaired learning and memory. Long-term effects remain to be seen
- When the cell phone signal is held next to the head, brainwaves are altered a full 70% of the time
- Many insurance companies are so alarmed by the evidence that they now exclude health issues

GUIDELINES FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE) VALUES FOR EMF FIELDS

Year: Standard	Magnetic Field Safety Level	
1992: ANSI/IEEE	205 μ T	
1993: NRPB	50 Hz: 1600 μ T 60 Hz: 1330 μ T	
1998: ICNIRP	General Public 83.3 μ T	Occupational 420 μ T
1999: The Swedish Standard	Video Display Terminals ELF (5 Hz-2 kHz): \leq 0.2 μ T VLF (2 kHz-400 kHz): \leq 0.025 μ T	
1999: Safety Code 6	General Public 2.75 μ T	Occupational 6.15 μ T
2002: ARPANSA	General Public 3 kHz-100 kHz: 6.1 μ T	Occupational 3 kHz-100 kHz: 31.4 μ T

0.1 μ T = 1 mG

ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronics Engineers (NEWYORK)
NRPB	National Radiological Protection Board
ICNIRP	International Commission on Non-Ionizing Radiation Protection
Safety code 6	Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency

related to cell phone radiation from coverage

- Most brain surgeons limit their cell phone use, and counsel patients never to hold them to their ears
- Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure. (*Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities*)

Conclusion:

As per the above discussion, there are two sources of electromagnetic pollution and their effects are different on human body.

- **IDENTIFICATION:** Determine sources of ELF fields. For example, a tri-axis Gauss meter could be used to determine the levels and locations of magnetic fields. Awareness is the best way to be safe
- **AVOID OR REDUCE THE USE OF PRO EMF EQUIPMENTS**
- **BE AWAY FROM EMF ZONE:** Place high load appliances away from those places where we spend a large amount of time
- **USE SHIELDING SOLUTIONS:** As a last solution, use shielding techniques to reduce the level of fields. Shielding ELF fields requires to divert the fields around the area considered sensitive to the magnetic fields


References:

1. Wikipedia. Sick building syndrome. (Internet) (July'2013) Available from: http://en.wikipedia.org/wiki/Sick_building_syndrome
2. United States Environmental Protection Agency (Internet) (July, 2013). Indoor Air Facts No. 4 (revised) Sick Building Syndrome.

Available from: http://www.epa.gov/iaq/pdfs/sick_building_factsheet.pdf.

3. Indian Journal of Occupation & Environmental Medicine. 2008 August; 12(2): 61–64. (Internet) (July'2013) The sick building syndrome. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2796751/>
4. American Academy of Environmental Medicine (Internet) (July, 2013) Electromagnetic and Radiofrequency Fields Effect on Human Health. Available from: http://www.aemonline.org/emf_rf_position.html
5. Safe Space Protection. Geopathic Stress Symptoms & Solutions (Internet) (July'2013) Available from: <http://www.safespaceprotection.com/electromagnetic-fields-geopathic-stress.aspx>
6. Electrical and Electronic Engineering. "Electromagnetic Waves", book edited by Vitaliy Zhurbenko, ISBN 978-953-307-304-0, Published: June 21, 2011. Chapter 22- Electromagnetic Waves and Human Health, By Feyyaz Ozdemir and Aysegul Kargi. (Internet) (July'2013) Available from: <file:///F:/Ph.D/ELECTROMAGNETIC/Electromagnetic%20Waves%20and%20Human%20Health%20%20InTechOpen.htm>
7. High Frequency Design, EMR & Human Health, Electromagnetic Radiation and Human Health: A Review of Sources and Effects, By Ali Zamanian and Cy Hardiman Fluor Corporation, Industrial and Infrastructure Group (Internet) (July'2013) Available from:

http://diyhl.us/~nmz787/biological%20radio%20research/Electromagnetic%20Radiation%20and%20Human%20Health__A%20Review%20of%20Sources%20and%20Effects__Fluor%20Corporation.pdf

8. International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 6, June 2012, ISSN: 2277-3754 ISO 9001:2008 Certified, Human Health and Electromagnetic Radiations, Author: Ankur Mahajan, Mandeep Singh (Internet) (July'13). Available from: http://ijeit.com/vol%201/Issue%206/IJEIT1412201206_18.pdf
9. BioInitiative 2012, A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation, (Internet) (July'13). Available from: <http://www.bioinitiative.org/>
10. Presentation on topic: Bioeffects and Therapeutic Applications of Electromagnetic Energy, Author: Riyadh W. Y. Habash, PhD, P.Eng, McLaughlin Centre for Population Health Risk Assessment, Institute of Population Health School of Information Technology and Engineering, University of Ottawa, (Internet) (July'13). Available from: <http://www.site.uottawa.ca/~rhabash/MontrealPresentation.ppt/> 

Dr. Anupama Sharma, Professor at MANIT Bhopal & Architect Santosh Tiwari, Research Scholar at MANIT Bhopal. Illustrations: Courtesy the Authors.
